Slide Material Test- Specification - Ch. Darve
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1 Goal

The purpose of the test is to measure the friction coefficient of several material combinations. The test is performed at nitrogen temperature and in vacuum.
This test will reproduce the same friction phenomena than the one between pins (linked to the cold mass) and support spider bushing of the IR Quad. Furthermore the run will permit to choose of the bushing material.

2 Principle of measurement

Two perpendicular loads F1 and F2 will be applied to several materials combinations, A and B, in order to measure the friction coefficient, *f*, at their interface.

$$f = F1/F2$$

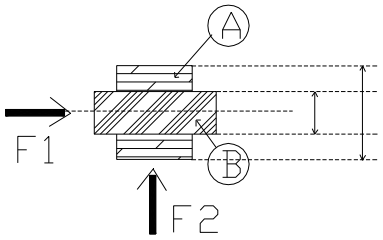


Figure 1: Measurement of the friction coefficient for a sub-assembly

The display of all parts should characterize the connection between the cold mass pin and the support spider bushing. If we consider the support system sequence, bushing-spider-bushing, the best fitted simulation is composed of 3 sub-assembly tested at the same time. The load F2 is only applied on the central material A.

The principle of the measurement is to apply a fixed load F2, and to register the load F1 versus the time, while increasing F1. The friction coefficient will be the ratio, F1/F2, with F1 equal to the value when the graph F1(t) will show a step.

3 Assembly and cryogenic set-up

Figure 2 illustrates the current display in the set-up.

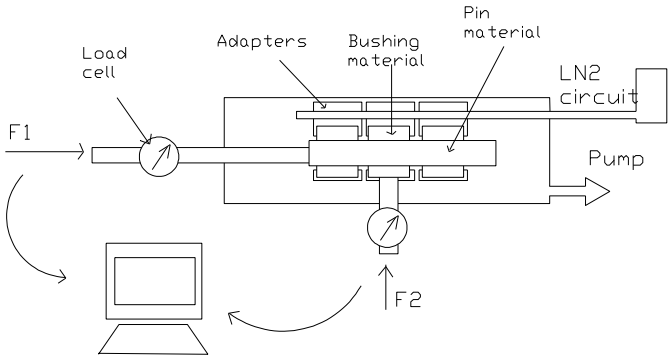


Figure 2: Test set-up

The assembly is installed in the Engineering Lab and will run in the insulation vacuum. The figure 3 shows the assembly drawing.
The load cells, items 35, will transmit F1 and F2, by the mean of two cylinders, item 34. Item 16 are adapters for the three sub-assemblies (bushing/pin), they are cooled at LN2 temperature.

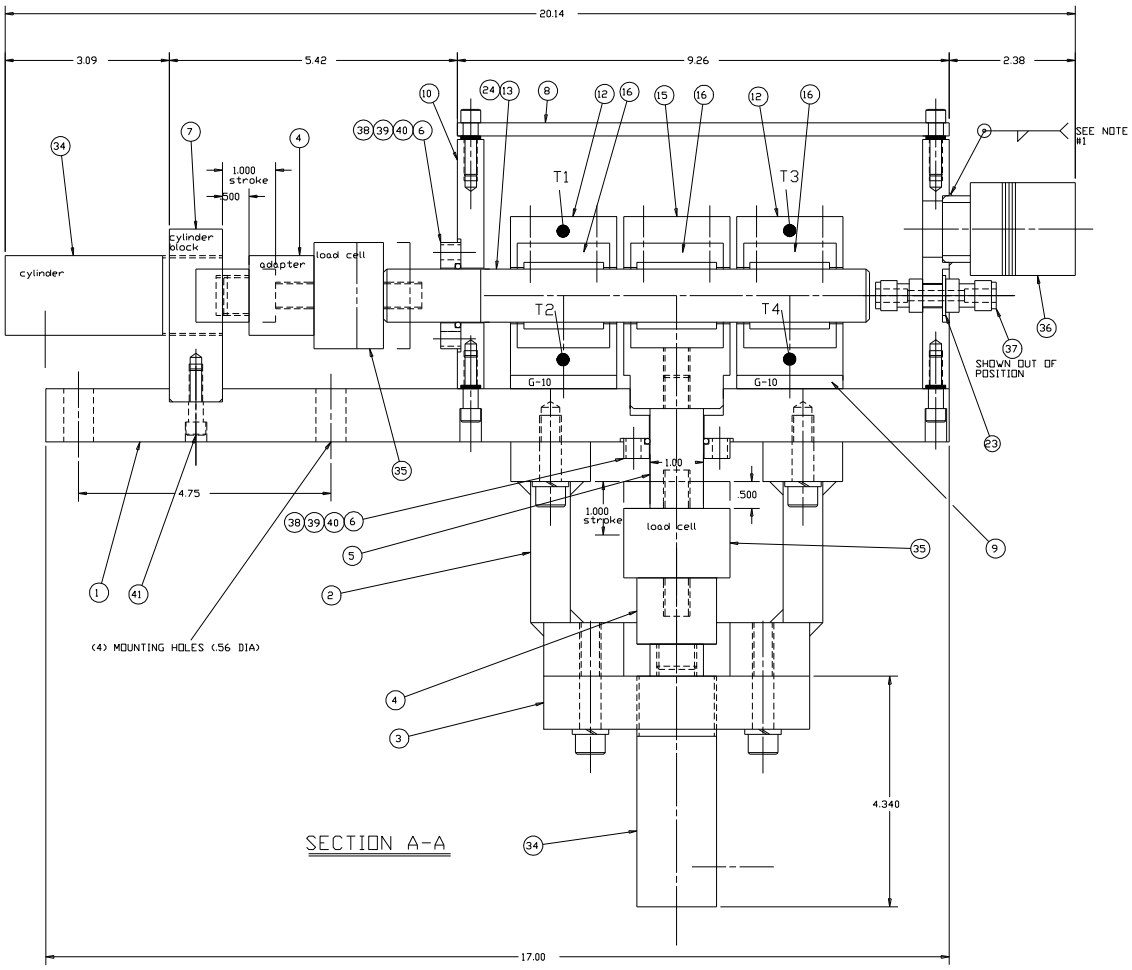


Figure 3: Assembly

4 Materials and loads

The different materials are referred in the table 1.
The dimensional comparisons with the real quad case are introduced in table 2.

Table 2: Dimensions of the tested materials

	Di bushing	Do bushing	Th. bushing
LHC-IRQ spider	50	54	2
Slide mat. test	19.05 to 25.4	25 to 31.75	3.17 to 2.975

If we consider the LHC, the weight of the cold mass (20,000 lbs) is transmitted to two supports spider via four pins (OD 50 mm). For the need of our test, we consider only a 25 mm diameter pin.
If we convert these ratios, we can estimate from 726 lbs to 1,290 lbs the equivalence of the load F2.
Table 3 shows the loads, F2, to use in the test, for a pressure equivalent to the IRQ conditions.

Table 3: Equivalent loads F2

	Diameter [mm]	Surf [mm]	Weight [lbs]
Case 1	19.5	284.88	725.8
Case 2	25.4	506.4	1,290.3

The friction coefficient of the given materials, found in the literature, are lower than 0.4, hence we can estimate that the load F1 should be smaller than 516 lbs.

In so far as we consider a larger range for the test, the selected calibrated load cells will convert the ranges:

F1 = -/+ 1,000lbs (453Kg)

F2 = -/+ 2,500lbs (1,133Kg)

5 Instrumentation

The instrumentation is summarized in table 4.
Four PT102 temperature sensors (T1, T2, T3, T4) are installed, in a hole of the adapters and glued thanks to some stycast. The load cells are calibrated in compression. The electrical schematic is shown in figure 4.

Table 4: Characteristic of the instrumentation

Instrumentation	**Excitation**	**Output**	**Use/ qty**
PT102	100 microamp	2 mV	Temperature of adapters/ 4
Load cell	10 V dc	2 mV / V+/-25%.	Calibrated force/ 2
Cylinder hydraulic	10,000 psi (700 bar)	5 ton	Provide the force on load cells/ 2
Pressure transducer	-/+ 15 V		Vacuum measurement/ 1
1 mass flow-meter	5 V		N2 control/ 1

6 Operating procedure of the set-up

1. Pump the tank to 1E-3 mbar.
2. Purge the N2 circuit.
3. Fill the circuit with the LN2.
4. Start acquisition of data: F1, F2, T1, T2, T3 and T4.
5. Stabilization of the recorded temperatures.
6. After one minute, apply F2=250 lbs continuously.
7. Increase F1 from 0 to 100 lbs (pushing the pin) and record several data.
8. Increase F1 by step of 100 lbs and repeat 7.
9. Repeat 7 and 8, (pulling the pin back) with F1 from 1,000 to 0 lbs.
10. Increase F2 by step of 500 lbs and repeat 7., 8. and 9.
11. Warm up to RT.
12. Installation of the next combination.
13. Repeat all the procedure.

The tested couples of material can be as numerous as the combinations in the table5.

As mentioned in paragraph 1. we register the evolution of the load F1(t), for a given load F2. The focused F1 is representative of the step in the curve F1(t), for a given F2. Indeed, the following table 5. should be completed for each set-up, with the value (F1/F2).

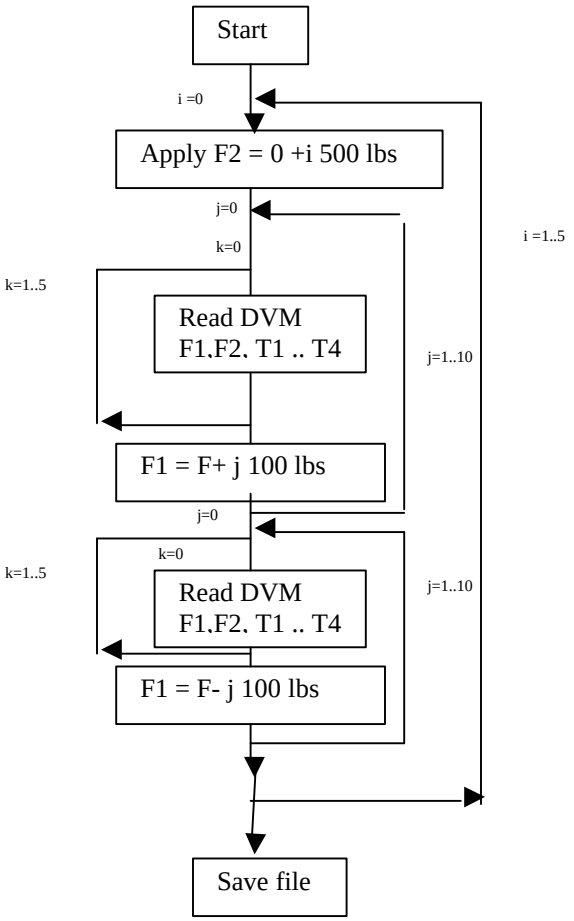
Mat #	1	2	3	4	5	6	7	8	9	10
11										
12										
13										
14										

Table 5: Results table

7 Acquisition

The acquisition program "SMT.bas" is written in quick basic. It will enable to

Organigram for the acquisition



The program will enable to change the parameters in order to vary the number of data points:

- Imax (5 by default)
- Jmax (10 by default)
- Kmax (5 by default)